Proposal of Convergence of e-Learning Systems for t-Learning

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Abstract—**This article presents considerations about viability on reutilize existing web based e-Learning systems on Interactive Digital TV environment according to Digital TV standard adopted in Brazil. Considering the popularity of Moodle system in academic and corporative area, such system was chosen as a foundation for a survey into its properties to create a specification of an Application Programming Interface (API) for convergence to t-Learning characteristics that demands efforts in interface design area due the fact that computer and TV concepts are totally different. This work aims to present studies concerning user interface design during two stages: survey and detail of functionalities from an e-Learning system and how to adapt them for the Interactive TV regarding usability context and Information Architecture concepts.**

Index Terms—**e-Learning, t-Learning, interactive TV, edutainment, information architecture.**

I. INTRODUCTION

Distance learning has been used for a long time and involves a model with or not a computer support. In this line, e-Learning (electronic Learning) involves distance learning course with support of a conventional computer connected to Internet (or not) with many features to user interaction (professor and student). This environment proportionate an exchange of materials and knowledge through the digital way. Analyzing Brazilian reality, it is possible to visualize two different scenes: (1) the increasing use of e-Learning systems (14% of trainings was made by e-Learning format in 2000) indicated by e-Learning Brasil [3] and (2) among 89.6% of houses with electrical power access only 14.2% have a microcomputer and 90.4% have a television device [16].

In this way, TV can be considered as a powerful source of information and entertainment. This fact justifies the capacity of Digital TV as a affordable technology for social and digital inclusion in Brazil [24] being able to make available educational material and to reach a great number of people that don't have access to a computer with necessary configurations, like software and internet connection, to use a e-Learning system.

Digital TV, different from conventional TV, offers interactive resources and access to digital contents by screen and remote control. Furthermore, e-Learning systems already used by education institutions and companies can be reused in this context due the fact that these systems development expended time and effort. It's useful to emphasize that distance learning through a TV or similar device is called t-Learning - a subgroup of e-Learning. However, the TV environment restricts a set of functionalities generally implemented for a computer. It is the case of collaboration tools that joins professor and student.

As a first activity for this work, the analysis of functionalities from e-Learning system Moodle [11] was made to map which functionalities have appropriate characteristics to be used on Interactive Digital TV with necessary reconfigurations. Such survey was associated with other e-Learning systems like TelEduc, AulaNet, .LRN, etc, contributes for the specification of a convergence application. Moodle analysis involves information regarding its capacities, how its structure comprehends IEEE Learning Technology System Architecture [5] and in which way its functionalities will be limited in a device totally different in different aspects.

To create an efficient user interface, Information Architecture [22] concepts have been applied as a way to understand this new user interaction approach and then to design and create efficient user interface for the final user: IA defines the structure of elements for an interface of any type of system, that can be since a website until a business application providing one better user experience. IA project includes stages to understand necessities of end user to create a well defined structure, navigation model and usability tests.

In this direction, the project development aims to bring to TV existing e-Learning systems, intending to reach a major public through the convergence of e-Learning systems to Interactive Digital TV. As part of the project, this work has as objective to present the analysis of Moodle functionalities that have greater affinity to t-Learning properties, considering interaction limitations, and an interface design prototype capable to enhance this new experience.

II. INTERACTIVE DIGITAL TV OPPORTUNITIES

A. iTV

The main difference between conventional TV and Digital TV comprehends the signal (analogical or digital) and the fact that digital signal demands a specific equipment called Set Top Box (STB) allowing TV device to show the digital received content. Digital TV provides a new environment for TV where viewer starts to be considered as a "user" with a remote control to support interaction with screen elements like images, texts and videos. In this new context, user has access to applications based on a new model of user interaction that involves basic functions as navigation, interaction and security.

Navigation functions features navigate between elements available on screen search and select and confirm options. Interaction functions allows user initiate, interrupt, modify and control multimedia content and security functions allow access control to information keeping data integrity.

These characteristics are part of know Digital TV standards but characteristics as mobility and interactivity were key points to choose ISDB standard (Integrated Services of Digital Broadcasting) as standard for Brazilian Digital TV. The objective was create a technological platform with multiple services offering high level services since high quality videos to organized information on screen (like electronic programming guide or information related to broadcasting video). These features was possible due the segmentation of band, creating subdivisions in an only channel guaranteeing diverse communication services and allowing the total convergence of the televising transmissions with the Internet, cellular phones, among others [1][24].

Bring e-Learning courses and its content to Digital TV is a valid alternative considering the technological platform of Digital TV in Brazil. On the other hand, this discussion implies in research around restrictions imposes by this device combination (a TV set and a remote control) including aspects like distance between screen and viewer and consequently requiring images and texts being larger size, that is, greater than normally used in a computer. Remote control, as device to interaction, limits user interaction because a low number of buttons and an experience based on only one hand. All this characteristics depends on STB to execute however, this is another point to discuss considering that STB features less resources than a computer and it is not able to execute processes and functionalities with a great power of processing or use any software.
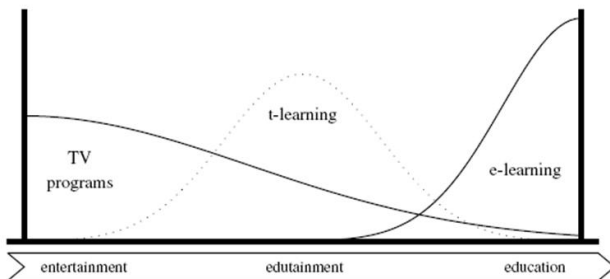

Figure 1.   The scope of t-learning: between pure entertainment and formal education.

B.   E-Learning and t-Learning Approaches

E-Learning systems use the benefits of Internet to offer courses on-line, with resources that guarantee motivation and a good performance of learning from participants. An e-Learning system via Internet takes advantage of all features from existing presentation layer of web sites and offers a rich interactive environment providing more value for student and professor. Even so many advances on interface and user interaction in the computer, Digital TV has limited capacity due STB hardware and software. According to Figure 1 [15], distance learning in TV follows the trend of education mix with entertainment, known as edutainment – a new approach [27] that takes advantage of one environment with recreation aspects and a rich experience in interaction and information providing a high degree of user motivation.

III.   E-LEARNING SYSTEMS CONVERGENCE FOR INTERACTIVE DIGITAL TV PROJECT

This work is a part of the project for developing an API for the convergence of e-Learning systems to Interactive Digital TV regarding t-Learning aspects. This API has access to e-Learning database and then it's capable to map relevant data from specific functionalities supported by TV environment. According to Figure 2, professor creates contents to his/her course and the application from TV side will access this data to show on TV screen and then providing mechanisms to receive and process answers sent by user. In this way, communication between professor side and student side is handled by a web service that makes possible the integration of data layer and presentation layer.
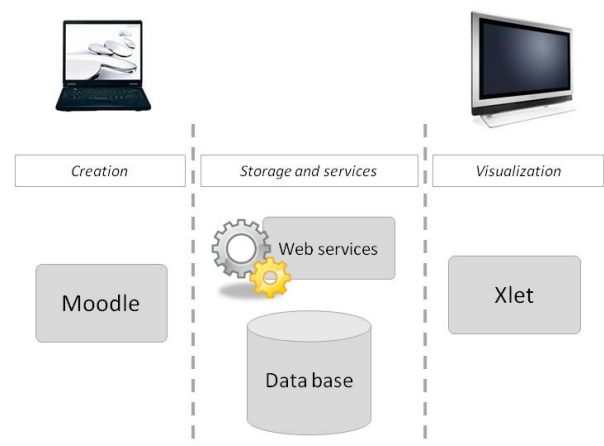

Figure 2.   System architecture including layers of convergence API.

For the development of presentation layer or TV side, it was choose the use of JAVA TV API [18] as a base for the TV application. This API created from Java platform is an optional package for platform J2ME and supplies to the receivers of Digital TV functionalities as audio flow of and video, conditional access, access to the data in the transmission canals, control of the tuner of canals, synchronization of the media, and management of the cycle of life of the applications. JAVA TV API based applications are called Xlets and are different from Applets that are executed in web browsers. JAVA TV API was developed to be a technology capable to demand requirements from companies interested in the easiness of the access and the dissemination of the knowledge of the technology. Xlets created for this project will be executed and tested on emulator XletView [23] because this platform and JAVA TV API is compatible with the Digital TV allowing future migration of to a real environment of transmission and reception.

A.   Moodle Functionalities Study

Moodle is a Content Management System (CMS) that offers on-line resources to facilitate management and the access to content of an e-Learning course by tools to assist professor and student. This system was initially developed by Martin Dougiamas [11] and was in continuing development by its community on web. Currently, 23,091 small web sites had been registered using Moodle, adding 210,296 users. Moodle is adopted by innumerable education institutions and companies because its structure concerns how to reach in efficient way objectives from an

on-line course or present courses that use as a support for presence activities format.

Users in Moodle are differentiated in categories: administrator, course creator, professor and student. In this work will be analyzed functionalities related to student that involves activities where student has access: visualizes, interacts and collaborates.

Initially, courses are grouped by categories defined by the administrator. The functionalities available for Moodle courses are treated as "activities" and can be grouped in survey, construction, evaluation and opinion groups. Survey tools include activities that provide resources to provide communication between users. Construction tools identify activities to create and edit content in a manner that user can contribute and collaborate. Evaluation tools assists professor to help evaluating student's performance considerating level of learning and participation. And, opinion tools, professor can use activities to apply questionnaires to better know opinion of students about any subject.

Considering this functionalities analysis it is possible to make an analogy with architecture IEEE Learning Technology System Architecture. Such architecture focuses only the technological side, that is, it does not have commitment in analyzing the psychological and pedagogical aspects of an e-Learning system. IEEE LTSA considers the following components, as illustrated in Figure 2 [5]: Learner, Evaluation, Coach, Delivery, Learner Resources and Learner Records. Learner is an entity that is treated as a student and it's linked to Evaluation entity responsible to providing features for evaluation of Learner like support of database Learner Records to execute computational processes to analyze student performance. System Coach comprehends a more complex process because it's responsible for define the appropriate educational material to Learner by analyzing his or her performance to provide content from Learning Resources.

TABLE I. MOODLE 1.6 FUNCTIONALITIES RELATED TO USERS SET AS STUDENTS.

Study about Moodle Activities		Choice	View	Write	Upload
Chat (real-time synchronous discussion via the web)	Discussion	-	Simple	Moderate	-
Forum	Discussion	-	Simple	Moderate	-
Workshop (participant's projects)	Discussion	-	Moderate	-	-
Database (allows participants to build, display and search a bank of record entries)	Build	-	Moderate	Moderate	Difficult
Glossary	Build	-	Simple	Moderate	-
SCORM	Build	-	Moderate	-	Difficult
Wiki	Build	-	Moderate	Difficult	-
Assignment (allow students to upload any digital content for grading)	Evaluation	-	-	-	Difficult
Lesson	Evaluation	Moderate	Moderate	Difficult	-
Quiz	Evaluation	Simple	-	-	-
Choice (quick pool)	Opinion	Simple	-	-	-
Survey	Opinion	Moderate	-	-	-

In this work, activities from a Moodle online course were classified according to its possibilities and capacities on user interaction: (1) select options; (2) visualize content (text, images, videos, animations, presentations, etc.); (3) input text; (4) upload files. The complexity degree is based on the characteristics and limitations discussed about interactivity on TV.

As it seen on Table 1, online questionnaires (Quiz, in evaluation category) and selecting alternatives (Choice, in opinion category) are identified as "simple" as complexity degree making possible the conversion to Interactive TV, considering that these processes involve navigate and select options and then, confirm one or many options. Visualization of specific contents, as images and videos, is simple too considering that images are better showing on TV instead text. Visualization of texts, as a long article for example, presents moderate complexity, due to amount of text to be shown on a screen that needs to enlarge image as much as text. Input text and upload files demand a higher complexity because input text demands an optional keyboard and upload suggests that the STB has storage features that doesn't stimulate affordable equipments.

To conclude this cycle, Learner has support of Delivery component to connect to system and then receive contents in any format support by the system architecture.
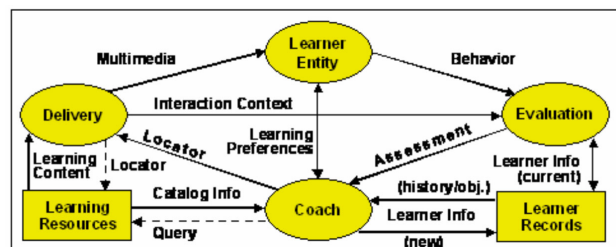

Figure 3.   IEEE LTSA comprises a technological approach for learning technologies [5]

According to edutainment theory, learning resources on TV demands a high quality application regarding characteristics capable to create an interesting and motivating environment. Considering that applications most propitious to TV environment are those that use interaction resources in high scale and at the same time

they offer entertainment points so, these characteristics can be intersected with components from IEEE LTSA. The most appropriate component for implementation is Evaluation that comprehends activities Quiz, Choice and Survey. They involve questions, answers, images, videos and sounds - what it makes possible to evaluate with entertainment mixture.

As already mentioned, an e-Learning system has to be motivating to keep student focus on his or her activities. On the other hand, applications for TV have aspects that embrace importance of motivating factors due a new paradigm of interaction. Ahead of the analysis on Moodle functionalities, it's necessary to map which data from e-Learning it is possible show on TV based user interface further questions regarding navigation.

Quiz activity is based on questions of multiple choices and comparing this activity on a conventional computer provides a visualization of all questions with alternatives (using, for example, checkbox component) plus image, video or animation. Moreover, the interface shows buttons for navigation that includes button for confirmation and the button for cancel - in the context of a computer, user makes use of innumerable information.

B. User Interface Design Proposal

Interface design project is essential and is a work that involves developing a complex and transparent application. Information Architecture area defends that it's necessary making this mapping considering factors as usability. Following these aspects, it's possible to conceive a schema for hole architecture that user interface involves. So, it's possible to create a basis to make available visual information and then bring to the user a structured environment facilitating his or her use.

The studies of IA for the project of convergence for the TV are necessary to create a new user interface where the minimum of text is shown due reading is a difficult process. So, it's important to provide more space for graphical elements and interaction components raising the degree of entertainment of activity. According to Figure 2, the project comprises two applications for user: professor and student. For student application, or that one that will be executed on TV, structure was created, as seen in Figure 3.
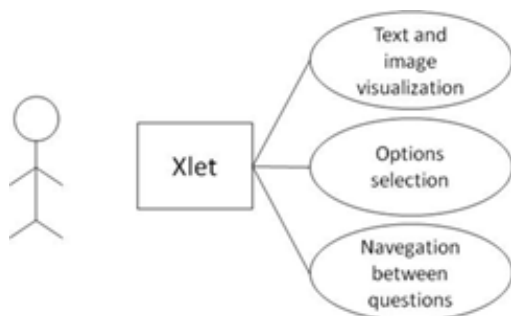

Figure 4. User interaction based on elements from Interactive TV

As seen in Figure 4, user has limited to three interactions model within the application: (1) visualization of text and graphical elements, (2) navigation between alternatives and consequently selecting of one or more options and (3) the navigation between buttons to confirm

and follow to next one or come back to the previous question. Based in this survey, he interface project was created to valorize the elements organization on TV screen and also was considered the limitations of the interaction of the remote control.

With the results from this study it was possible to evaluate the functionalities of an environment of e-Learning that are more propitious for the environment of the TV, considering limitations of the Interactive TV and t-Learning characteristics, like edutainment aspect. The following stage involved the analysis of user interface together with Information Architecture concepts, a key point to develop an interface structure to guarantee an excellent level of user experience. Figure 5 illustrates the result of the study, where the three different areas related to three items of interaction map previously and the interaction related with a remote control from a STB.
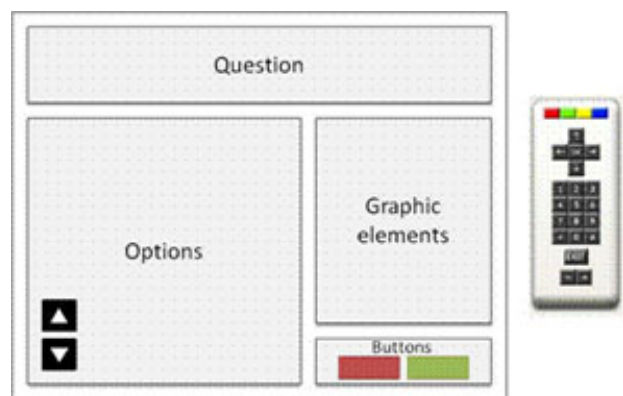

Figure 5. Interface design prototype based on specific Xlet to be used for Moodle evaluation activities.

IV. FUTURE WORK

The user interface project is part of the project for the development of an API for the convergence of a system of e-Learning for t-Learning. Next steps involve how to structure API architecture, web service implementation responsible for communication layer and development of the application for the TV based on JAVA TV API.

V. CONCLUSION

E-Learning systems are used due its low cost to maintain and the easiness of participating on an online course. On a user point of view, infrastructure cost to access an online course still is expensive for a massive part of the studied population, in case, Brazilian. On the other hand, TV is a device present in many houses. To lead e-Learning for TV (t-Learning) is subject in direction of digital inclusion because Interactive TV allows access to contents of different areas and modalities for users especially that do not have a computer.

In this context, the analysis of Moodle functionalities was presented using an analogy with IEEE LTSA and Information Architecture. In this way, it was possible to identify functionalities that can be used on Interactive TV according to its complexity. In this analysis the visual functionalities that involve simple interactivity features had been map to contribute for the motivation of student. Similar analyses were made for other e-Learning systems, constituting one of the stages of this project.

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